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ABSTRACT

A study was designed to develop to operational status a computer-assisted instructional (CAI) unit on household electricity for an introductory course in household equipment. A second purpose of the project was to obtain data on development time in relation to student on-line time. The unit consisted of four modules, one each on electrical terms, safe use of electricity, a household circuit game, and the cost of electricity. A CAI unit called "heelec" was prepared, evaluated by its users and judged acceptable by students and instructors. Development time was comprised of author time and computer related activity time; records showed that author time and computer related activity were nearly equal for each of the four modules, thus supporting the conclusion that two distinct kinds of specialists--content authors and computer personnel--are needed to develop CAI units. The ratio of total development time to student on-line time was 137:1. (LB)

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AN ANALYSIS OF DEVELOPMENT/USE TIME RATIOS FOR A COMPUTER ASSISTED INSTRUCTION UNIT ON BASIC HOUSEHOLD ELECTRICITY

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This study was designed to develop to operational status a computer assisted instruction unit on household electricity for an introductory course in household equipment. A second purpose was to obtain data on development and authoring time in relation to student on-line time. It was anticipated that such information should be useful in planning stages for other authors considering development of computer assisted instruction programs. After summarizing the unit evaluation, the major focus of this presentation will be on the time ratio information obtained.

The basic household electricity unit consisted of four modules: Module 1--Electrical Terms, Module 2--Safe Use of Electricity, Module 3--Household Circuit Game, and Module 4--Cost of Using Electricity. Modules 1, 2 and 4 were written in the tutorial mode and module 3, in the simulation mode.

The unit with the accompanying manual was evaluated by undergraduate and graduate students and by professors in the subject matter area. Acceptance of the CAI program by students and professionals was determined through administration of specially designed questionnaires, answers recorded by the computer to an evaluation segment in the unit and the review and reuse of the program by the professors teaching the undergraduate household equipment course. Acceptability of the CAI program, named "heelec," was defined as the recommendation by individuals through responses on an evaluation questionnaire to continue use of the program as a useful tool in learning or teaching household electricity. Greater acceptance by users was found for all tutorial modes (modules 1, 2 and 4) than for the simulation segment (module 3). Of all respondents using the CAI unit, 81 per cent recommended continued use of the tutorial modules in the household equipment course for which the unit was

designed and 52 per cent favored continued use of the simulation module.

The computer recorded the input from 85 undergraduate students from two classes who used part or all of the basic household equipment unit, "heelec," during winter quarter of 1973 at The Ohio State University (Table 6). Fifty-three of the 85 students returned an evaluation questionnaire. Of the 53 respondents, 26 had and 27 had not been previous users of CAI.

Responses on the student evaluation sheet indicated, in general, acceptance of the unit although opinion ranged from "Liked Very Much" (5) to "Disliked" (1) on a five point scale. Ninety-one per cent of the respondents rated the unit as 3 or higher.

Forty-seven students (89 per cent) went beyond the first half of module 1. This, as well as the student rating of "heelec," suggests that there was no strong dislike of the unit, especially in view of the fact that one class of 34 students was required to use only the first module.

Students' first preferences for how the electricity unit should be used in the household equipment class was tabulated (Table 8). For all students, the largest number of first place responses were for "in place of reading references" while the students who completed the entire unit favored "supplement to lecture."

"Lack of time" was the most frequently checked reason for stopping (Table 9). None checked that the unit was too difficult.

All 53 respondents ranked the options on how the "heelec" unit might be assigned (Table 10). The largest number of respondents, 34 or 64 per cent, checked as first preference "part optional, part required." "Required" was slightly more favored by students who had used computer assisted instruction before and by those who completed the entire unit (4 modules) than by other

respondents.

Four phases were passed through in developing the Basic Household Electricity Unit:

Awareness and Preparation

Commitment

Module Completion

Unit Utilization

Development is defined as the total process of creating an operational program by an author using human and non-human resources.

One of the objectives of the study was to keep time records during module completion which would permit establishment of relationships between development and author time for a CAI program and student terminal use or on-line time. Student terminal use time in hours is the length of time the student is on-line to the program via a teletypewriter. Time used by individual students at the terminal was recorded by the computer, utilizing counters in the program.

Data were obtained on manpower hours used by the author and support personnel in the development to operational status of each module of the unit in basic household electricity. Two major divisions in time records for module development in this study were: content writing of modules and computer related activity. Module writing time was conceived to be primarily associated with the development of subject matter information--research, design and text writing. The computer related activity was recorded to document the technical specialist's support time needed by the author to complete a program. Further sub-divisions of major time categories for program development included the following:

Content Writing of Modules

Research

Correspondence

Consultation (subject matter)

Initial writing

Modification after use

Secretarial assistance

Development of manual

Computer Related Activity

Consultation (CAI)

Training in Coursewriter

Coding and module input

Debugging

The total time for content writing of the modules plus computer related activity is referred to as the development time.

Writing of the program content simultaneously with the design of necessary illustrations required a total of 186 hours of author time (Table 1). For every concentrated author time block available, only about 50 per cent could be used productively or recorded as actual writing time. The principal reason for this low rate of productivity was the tedium experienced such as checking of facts, and close attention to programming detail associated with the writing.

Tutorial mode was used in writing modules 1, 2 and 4, and simulation mode was utilized for module 3. The simulation segment, the household circuit game, required more author time than other modules in working with the coder, approximately 24 hours. Consultation on the simulation game (module 3) also proved to be more difficult than for those modules in tutorial mode. Con-

ditional moves were difficult to explain verbally or in writing. In addition, increased numbers of alternatives open to student choice proved more difficult to cope with than was the fixed flow.

The total time used was nearly equal for content writing of the modules (227 hours) and for computer related activity (214 hours). This finding supports the recommendations by CAI personnel that two groups of specialized people need to be involved in CAI program preparation: author plus assistants and competent staff at the CAI center.

For the tutorial mode (modules 1, 2 and 4), the total amount of time required from other people, 137 hours, (consulting, debugging and technical) amounted to about 81 per cent of the total time used by the author, approximately 169 hours. On a module basis, the time contributed by other people was 76, 81 and 117 per cent of the time spent by the author for modules 1, 2 and 4, respectively. Preparation of the simulation module, on the other hand, required about 62 per cent as much time of other people as of the author (approximately 52 and 84 hours, respectively). Only one module was designed in the simulation mode; therefore, it was impossible to determine if the time used by the author versus time used by other people would remain in the same proportion if additional simulation modules were written.

Final manual design time was included with additional debugging time as "refinement after operational." These are additional hours (50 total) spent in development after all modules were declared operational and prior to the final student acceptability evaluation.

Accurate division of time among modules during development was difficult as any author could experience. One major reason was the overlapping of knowledge obtained in either subject matter or computer related activities

which was useful in preparation of each of the four modules. This was particularly true in conference time but effort was made to record the time per discussion of a given module.

Counters, a computer facility in Coursewriter III, were used in "heelec" to store the terminal time in minutes used per student per module. Ranges of time use by students are shown for each of the modules (overhead projectual).

Module	Student Terminal Use Range in Minutes
1. Electrical Terms	42[a] to 235
2. Safe Use of Electricity	30 to 58
3. Household Circuit Game	18 to 153
4. Cost of Using Electricity	19 to 38

[a]Eighteen minutes were recorded for one student who had signed on under two different identification numbers.

The on-line time used by all students using the unit in two household equipment classes were summarized to determine the development time to student on-line time. Two comparisons were made. Represented in Table 3 are all 53 students who used from one to four modules. The 24 shown in Table 4 represent the students who used all four modules. Very little difference occurred between the ratio of development time to student average on-line time for all students and for the 24 students who completed the four-module unit. These ratios were 134:1 and 128:1, respectively. The actual difference between these two groups in use per student averaged 9 minutes. If the 50 hours of manual development is added the total development time ratio is 137 hours to 1 hour of use.

As anticipated, the first module-writing attempt required more development time (32 per cent) by the author per hour of student use than did succeeding modules in the same mode. When the mode was changed to simulation, the

author used 60 per cent more time than the total writing time spent for tutorial per hour of use.

If author time rather than development time (author plus other people) is compared with the student on-line time, the ratio is considerably lower (Table 5). For the unit as a whole (all four modules) the average ratio of author to student use time for all students was 77:1. For the tutorial mode (modules 1, 2 and 4), for all students the ratio was 67:1 and for the simulation mode (module 3), 109:1. These ratios could be substantially reduced if the author employed a person to type the modules prior to input by a coder.

Authoring time estimates in the literature range from 25 to 200 man-hours per one hour of student on-line instruction. Avner estimated that for an experienced author on the PLATO project at the University of Illinois, thirty author hours to one program hour in tutorial mode were required. He did not define author versus development time. To develop "heelec," an average of 114 development hours to one hour of terminal use were utilized in the tutorial mode (modules 1, 2 and 4) whereas 175 development hours to one terminal hour were used in simulation mode (Table 3). According to this, a new author developing a simulation module will require more development time in proportion to student on-line time than he will for tutorial mode. Use of more than one mode and type of material presented were considered as two reasons for increased time used by this author over the man-hours reported in the literature.

Television, an education technological device, has been used for instructional programs at Ohio State University in home economics. In Logan's study lessons were developed in basic electricity and total production and preparation time was 111 man-hours per 30-minute tape or a ratio of 222

development hours to 1 student use hour. The cost of the development time for computer assisted instruction material has been stated as less than the cost of developing educational television.

In conclusion, the electricity unit was judged acceptable by the students and professional persons according to their answers to evaluation questions. The development time spent in content writing was nearly equal to that for computer related activity for each of the modules developed. Also, the time spent by the author in overall development was only slightly greater than that contributed by other people. The ratio of total development time which included 3 tutorial modules and one simulation module, to on-line time for this study was 134:1 without the manual and 137:1 with the manual.

Gailey, F. H. An Analysis of Development/Use Time for a Computer Assisted Instruction Unit on Basic Household Electricity. Doctoral dissertation, The Ohio State University, 1973.